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THE EVOLUTION OF ASTRONOMICAL INSTRUMENTS.

Zur Geschichte der astronomischen Messwerkzeuge von Purbach bis Reichenbach 1450 bis 1830. By Joh. A. Repsold. Pp. viii+132. (Leipzig: Wilhelm Engelmann, 1908.) Price 16 marks.

IN all that relates to the mounting of telescopes or the construction of instruments intended for accurate measurements, in all that increases their convenience or adds to their efficiency, the firm of Repsold has won a world-wide reputation, and the book before us indicates in some measure the reason for this marked success. The head of the firm has been a keen and interested student of the history of past construction. For more than forty years, the author reminds us, he has been engaged in furthering the progress of instrumental construction, and in this time he has given close study to all that has effected the gradual development of this branch of engineering technique. He has assimilated all that experience can teach, has learnt the strength and the weakness of the work of past masters, and has profited by their example and their attainments. We now in our turn have the opportunity of benefiting by the results of this close study, perfected by much examination and sifting, and in addition to tracing the evolution of modern instruments we get glimpses of the history of astronomy, viewed from a new and interesting standpoint. Obviously, the connection between the progress of astronomical science and the improvement in instrumental equipment must be continuous and intimate, but how close the tie is can hardly be apprehended until we make a historical survey of the principles of instrumental construction, on a plan which reveals the part played by successive makers, and makes us understand to what extent astronomy has been forwarded by their endeavours.

Although the author limits his review from 1450, when Purbach strove to give expression to his mechanical ideas, to 1830, when Traughton in England and Gambey in France were representatives of the art of instrument making, the survey cannot be restricted to precise dates. At one end we listen again to the description of the contrivances of Ptolemy, which served for models through so many centuries, and at the other we are permitted to see the beginnings of the famous house of Repsold, destined to influence the methods of future artists.

The author passes in review the mechanical efforts of the Arabians, whose claims to consideration have been extravagantly championed by Sédillot and as stoutly disputed by Delambre. He acknowledges the skill of the devices which enabled them to solve approximately a particular class of problems by mechanical means, but cannot find much to praise in their measuring instruments. The astrolabe and the so-called "sextant" meet with adequate recognition, but a careful consideration of the facts, which are set out with the clearness bespeaking the practical expert, leaves the impression that the Arabians did very little

to advance the means for making accurate observation. They imitated, they did not invent, and none of the generic improvements which have facilitated the subdivision of small intervals of time and space—the main problem which has engaged the attention of successive generations of instrument makers—on which accurate astronomy depends, can be placed to their credit.

Frequent reproduction has made us familiar with the forms of the instruments used by Copernicus and Tycho, who with Hevel may be regarded as the last representatives of a pre-telescopic age. But here, in addition to very complete illustration, we have from the pen of a competent authority a full technical description of those contrivances, accompanied by acute and illuminating remarks on the adequacy of the design to secure the end contemplated, the faults of construction, and oftentimes the reason for the adoption of particular methods. Down the stream of time this discriminating but generous criticism is pursued, necessarily affording a clearer insight into the difficulties and successes of individual artists.

The introduction of the telescope offered a new set of problems for solution. The continual increase in focal length compelled makers to abandon the sector form of instrument, such as the quadrant, and forced upon them the necessity of devising more appropriate means for measurement, though Halley and Bradley both used 8-feet quadrants. The employment of complete circles and the designing of instruments of greater symmetry in their several parts were the consequence, and no one displayed more ingenuity or foresight than did Römer. With justice, the author carefully discusses the work of this astronomer, whose claims to recognition have been very tardily admitted, mainly owing to Delambre's jealous partisanship of Picard. But Dr. Repsold has known how to do justice to the one without injury to the other. Römer in various ways anticipated modern design. His *machina domestica* was the prototype of the present transit instrument, his *rota meridiana* of the meridian circle, while his azimuthal instrument foreshadowed the introduction of the convenient universal instrument. The use of two bearings to carry a long axis of rotation, increased symmetry of structure, the adaptation of the reading microscope, the practice of determining instrumental errors by suitable mechanical means, were all as fully appreciated by Römer as they are to-day.

Considering how indispensable a micrometer is to a telescope, and how materially it increases the scope and usefulness, its evolution proceeded slowly, but the study of its many transformations is of singular interest. The urgency of the demand for the means of measuring the diameter of a planet seems out of proportion to its importance, but the solution of the general problem, containing as it does that of the accurate and convenient subdivision of small spaces, taxed the ingenuity of instrument makers severely. Huyghens proposed a thin wedge, which could be moved in the focal plane until the planet was exactly occulted, when the measurement of the breadth of the wedge at that point gave the diameter. A net-

work of small squares in the focus of the eyepiece was another favourite device which might have answered very well if the object to be measured exactly fitted the side of the square. Picard seems to have first imagined the use of the screw to move two plates of metal, similar to the slit of a spectroscope, but to measure the distance, if we correctly understand the description, he had to detach the micrometer from the telescope and place it under an ordinary microscope. Hooke supplied the movable wires as an improvement to Gascoigne's micrometer, and Auzout introduced the divided head. Römer gave us the spring to take out the "loss" of the screw, Traughton added the position circle, and so the tale goes on, showing the variety of processes and the slowness of growth necessary to ensure the perfected form that receives general acceptance.

The processes followed in dividing the limbs of graduated instruments is another subject which the author's practical knowledge and great experience can render peculiarly interesting, but we can say no more than that in this treatise, with its admirable illustrations, will be found a valuable collection of facts from which one can trace that growth of mechanical skill and improved technique, which have ministered so materially to the progress of astronomical science.

NATURE AND NURTURE OF THE CHILD.

An Introduction to Child-study. By W. B. Drummond, M.B., C.M. Pp. iii+348. (London: Edward Arnold, 1907.) Price 6s. net.

The Child's Mind: its Growth and Training. By W. E. Urwick, M.A. Pp. xi+269. (London: Edward Arnold, 1907.) Price 4s. 6d. net.

MR. DRUMMOND, who is already well known as the author of a useful primer on the nature and nurture of the young child, has written a more ambitious book, which "aims at supplying a fairly comprehensive introduction to child-study." His work, therefore, necessarily covers a wide field, ranging from facts of growth, defects of the special senses, and school hygiene, by way of the instincts, habits and interests of children, to their forms of expression and their moral and religious characteristics. On all these he writes interesting chapters prefaced by sections dealing with methods of investigation and other introductory topics.

On p. 87 the student is wisely warned against the over-enthusiasm exhibited by "a number of workers especially in America," some of whom "start with no definite object in view and not unnaturally arrive nowhere." It would doubtless be unfair to suggest that this severe criticism applies not inaptly to the child-study movement as a whole. Nevertheless, on turning the last page of this book one is tempted to ask whether it is possible to secure "the chief end of child-study," which is, we are told, "not only to collect facts about children," but also "to formulate them in such a way as to make them available for science and for the use of those who need them for application to practical problems," so long as even

such able exponents as Mr. Drummond give us little more than a mass of materials of widely different values, not always submitted to adequate criticism, and illuminated from no general point of view. This complaint should, however, be qualified by recognition that the author can scarcely fail to encourage sympathetic observation of children—a result with which he would, apparently, be satisfied.

By contrast with Mr. Drummond's book, the systematic unity of treatment that follows from adherence to a clearly conceived point of view is the most prominent characteristic of Mr. Urwick's. The author of "The Child's Mind" sees clearly that:—

"It is not sufficient for the purpose of education merely to collect and state facts drawn from these sciences [Biology, Physiology and Psychology] which seem to be relevant. . . . The rays of light coming from the different sciences must be focussed, passed, as it were, through a common lens, in order that the light thrown may be cumulative and concentrated rather than sporadic."

It may be said at once that he has performed the task thus indicated in such a way as to make his modestly announced "study" one of the most useful pedagogical treatises of recent years. He has given what is much more helpful than the best "psychology for teachers"—a consistent interpretation of the educative process as a whole as it presents itself under the more or less conventional conditions which actually determine it.

Mr. Urwick's treatment is based upon the modern concept of connotation. Human behaviour can be analysed largely into connotative processes which set towards or away from objects of positive or negative "immediate value." In relation to these immediate values other objects of perception or thought may have "final value." Education consists in the (indirect) teaching of a certain range of immediate values and the (direct) teaching of final values with reference to these. Thus immediate and final value replace in Mr. Urwick's scheme the Herbartian notion of interest. His treatment is in a sense complementary to the older doctrine, of which he gives fragmentary but interesting criticisms. The student will find it a valuable exercise to study "The Child's Mind" together with a representative exposition of the Herbartian psychology such as that of Prof. Adams.

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OUR BOOK SHELF.

The Essentials of Cytology. An Introduction to the Study of Living Matter. With a Chapter on Cytological Methods. By Charles Edward Walker. Pp. viii+139. (London: Archibald Constable and Co., Ltd., 1907.) Price 7s. 6d. net.

THE need for an elementary text-book on cytology has been felt for some years, and Mr. Walker has sought to meet it in the volume before us. There is much in the book that is good. The details of nuclear division in the higher forms are clearly presented, and the student is enabled to gain a clear idea of the process by means of the admirable and ingenious stereoscopic photographs which accompany the volume.